BATCHES OPENING
MATHS & PHYSICS
OCT 2024(AS & A2)
JAN & MAY 25 (AS & A2)

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UNIT 3 FAQ WORKSHEET

SEMI CONDUCTORS:

LDR:

JAN 22:

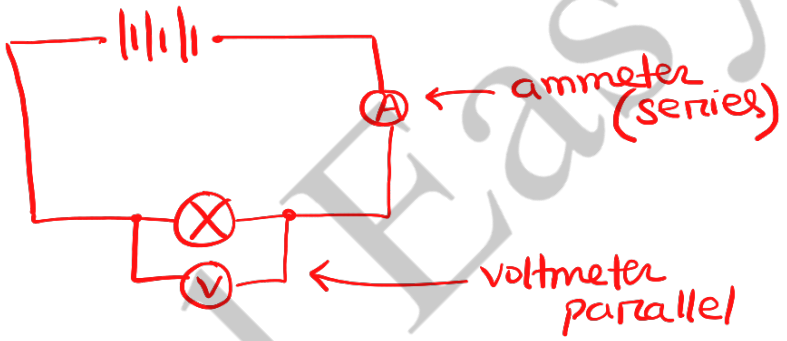
2 A student varied the power of a filament bulb to investigate the light emitted by the bulb.

(a) The student built a circuit to vary the power of the bulb. The student used an ammeter and voltmeter to determine the power of the bulb.

Draw a circuit diagram that the student could have used. (2)

P = IV.

Power ↑ ↓ I - bulb ↑ R ↑ ↓ R - LDR ↓. P



(b) The student shone the light from the bulb onto a light dependent resistor (LDR). The student measured the resistance of the LDR using an ohmmeter.

The student plotted a graph of the resistance of the LDR against the power of the bulb.

Describe how the student could have obtained the set of data required to plot the graph. Your description should include how to ensure that the data is accurate. (4)

RQ.

Change the power-supply voltage 5 times to collect 5 different data for current and voltage. Then using the Eqn : P = IV, use those data to calculate the power for each reading. Now measure the Resistance in LDR using ohmmeter for every power. To keep the experiment fair, conduct this in dark room to control background light and distance between LDR and bulb should be fixed.

(c) The LDR is connected to the ohmmeter using two connecting wires. The ohmmeter reading includes the resistance of the two connecting wires. State why the student does not need to correct this reading. (1)

Resistance in wires are negligible compared to that of LDR.

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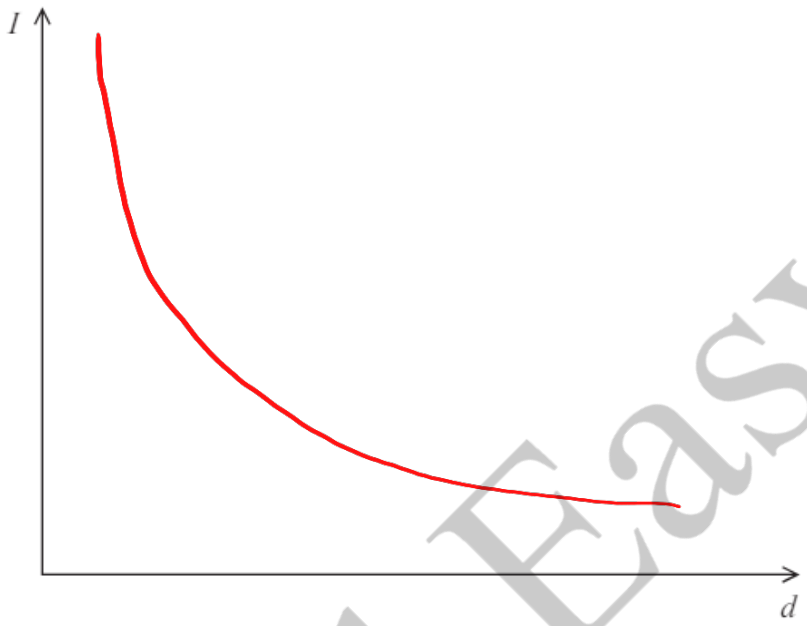
JUNE 22 Q3

(c) Sketch the relationship between I and d on the axes below. (2)



(e) (i) Identify one control variable in this investigation. (1)

Background light

(ii) State how this variable can be controlled. (1)

conduct experiment in dark room.

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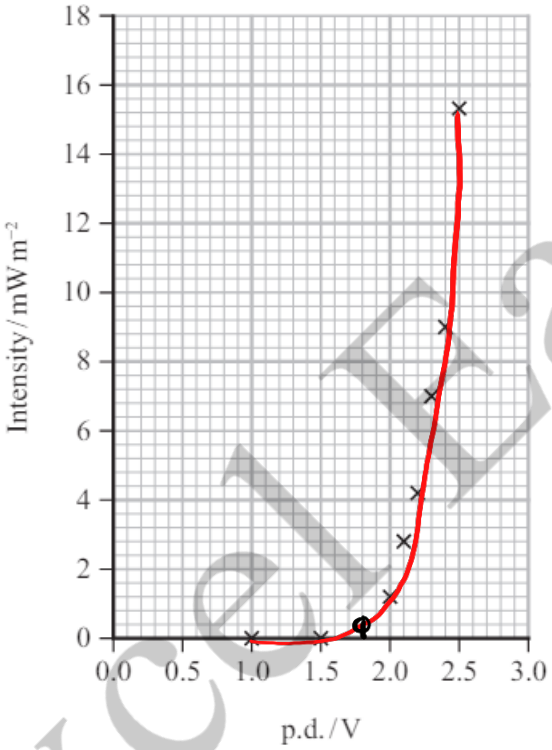
LED:

OCT 20

2 A student investigated how the intensity of light emitted by a light emitting diode (LED) varied with the potential difference (p.d.) applied across the LED. She measured the intensity of the light using a lightmeter which was shielded from external light sources.

She plotted her results on a graph as shown.



Light Intensity ↑
↓
Resistance ↓
↓
I - LED ↑
↓
V - LED ↑.

(a) Add a line of best fit to the graph.

(1)

(b) (i) Give the value of the p.d. at which the LED starts to conduct.

= 1.8 V.

(1)

(ii) Calculate the minimum energy that must be transferred to an electron in the LED for light to be emitted. (2)

$W = VQ$

$= 1.8 \times 1.6 \times 10^{-9}$

$= 2.9 \times 10^{-19}$ J.

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(c) Light is emitted when the electron releases energy as a photon.

The student tested a second LED which emitted light of wavelength 625 nm. → 625×10^{-9}

From her results she determined the minimum electron energy to be 3.1×10^{-19} J.

Calculate the value of the Planck constant from this data.

(3)

$$E = \frac{hv}{\lambda}$$

$$\Rightarrow h = \frac{E \times \lambda}{v} = \frac{(3.1 \times 10^{-19}) \times (625 \times 10^{-9})}{(3 \times 10^{8})}$$

$$= 6.5 \times 10^{-34} \text{ Js.}$$

(d) The LED does not produce monochromatic light. RQ//

Explain how this would affect the value of the Planck constant calculated.

(3)

Then LED would produce a range of wavelength for which a range of planck's constant would be calculated. If the wavelengths are bigger then largerc value of planck's constant would be calculated.

(e) The accuracy of the value of the Planck constant calculated depends on the minimum p.d. determined from the graph. RQ//

Explain how the student could reduce the uncertainty in her value of the minimum p.d.

(2)

Take additional measurements within the range of 1.5V to 2.0V. This will allow us to draw a graph of line of best fit to more accurately.

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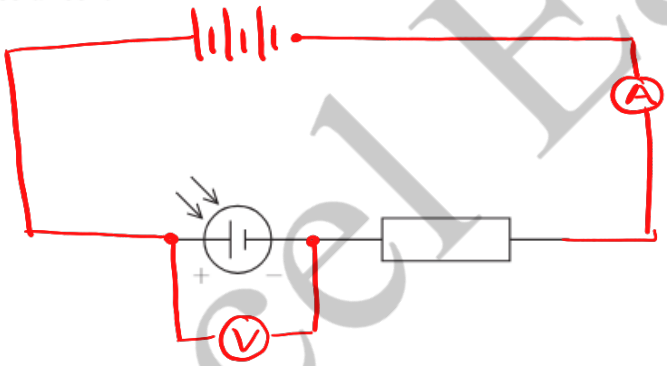
3 A student investigated how the power output of a solar cell is affected by temperature. The intensity of light incident on the solar cell remained constant.

He used a square solar cell, as shown.

The student determined the power output of the solar cell at different temperatures.

(a) Complete the diagram to show a circuit that would allow him to determine the power output of the solar cell.

(2)



(b) Describe how the student could ensure that the intensity of light incident on the solar cell remained constant. (2)

conduct this in dark room to control background light and light should be emitted from one bulb with known powere. keep distance and angle between solar cells and bulb same.

(c) State a method the student could use to increase the temperature of the solar cell. (1)

Using a hair dryer with a fixed distance and power.

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(d) At room temperature, the student measured a potential difference of 2.74V and a current of 45mA for the solar cell. Calculate the power output of the solar cell. (2)

$P = IV$

$\Rightarrow P = (45 \times 10^{-3}) \times 2.74.$

$= 0.12\,W.$

Intensity = Power / Area

(e) He measured the intensity of the light incident on the solar cell to be 200Wm^{-2}. Calculate the efficiency of the solar cell at room temperature. dimensions of solar cell = 60mm × 60mm (3)

$P = 200 \times (60 \times 10^{-3})^2 = 0.72\,W.$

$\text{Efficiency} = \frac{\text{useful}}{\text{input}} \times 100 = \frac{0.12}{0.72} \times 100$

$= 17\%$

(f) The student made measurements of the potential difference V and current I for the solar cell over a range of temperatures.

RQ

His results are recorded in the table.

Temperature / °C	V / V	I / mA
15	2.76	45.8 (3)
20	2.62	47 (2)
30	2.46	48 (2)
50	2.05	51.5 (3)

(i) Criticise these results.

Too few readings and a small range (2) of temperature are taken. There is no consistant interval in temperature readings. There is inconsistant significant figures in current.

(ii) Over the range of temperatures shown, the relationship between the power output of the solar cell and its temperature is linear. Describe how the student could use a graphical method to determine the change in power output for each 1°C of temperature increase. (3)

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Ans: Measure I and V for each 1°C increase in temperature and calculate power for each data using $P = IV$. Then plot a graph of P on y-axis against Temperature on x-axis. Calculating gradient $\left(\frac{\Delta P}{\Delta T}\right)$ will give change in Power for each 1°C increase in temperature.

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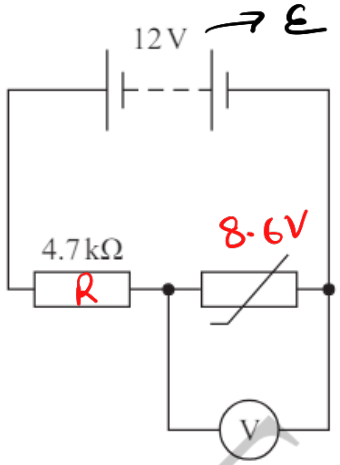
THERMISTOR: $R \propto 1/T$.

OCT 21

1 A student investigated the behaviour of a thermistor using the circuit shown in the diagram.



She heated the thermistor to 100 °C and measured the potential difference V across it. She decreased the temperature θ and recorded further measurements of V and θ until the temperature reached 10 °C.

(a) Describe how the student was able to vary the temperature θ of the thermistor for this investigation.

(2)

Heat the thermistor to 100°C using a hair dryer. Then cool it by 0 using freezer.

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(b) The photograph shows the steady reading of V on the voltmeter when the thermistor was at room temperature. → 25°C

(Source: PAL)

Calculate the percentage uncertainty in the value of V shown.

(2)

Resolution = 0.01V.

Uncertainty = $\frac{\text{Resolution}}{2}$

$= \frac{0.01}{2} = 0.005$

% Uncertainty = $\frac{0.005}{6.85} \times 100\%$

$= 0.073\%$

$= 0.07\%$

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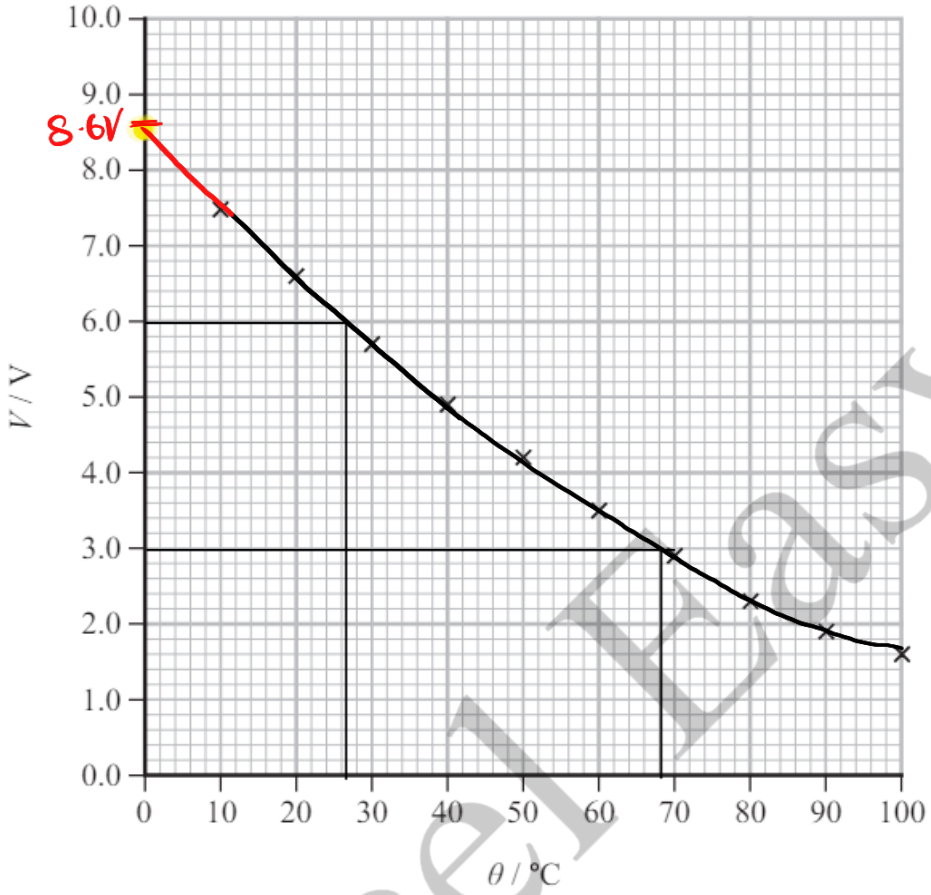
(c) The student plotted a graph of her measurements of V and θ.



(i) Estimate the value of V for a temperature of 0 °C. (2)

$= 8.6\,V$

(ii) Calculate the resistance of the thermistor at a temperature of 0°C. (3)

$V_R = 12 - 8.6 = 3.4\,V.$

2 Resistors are connected in series.

$I_R = I_T$

$\Rightarrow \frac{V_R}{R_R} = \frac{V_T}{R_T}$

$\Rightarrow R_T = \frac{V_T}{V_R} \times R_R$

$R_T = \frac{8.6}{3.4} \times (4.7 \times 10^3)$

$= 11888.23529$

$= 1.19 \times 10^4\ \Omega.$

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(d) The student suggested that V is inversely proportional to temperature measured in kelvin. Determine whether she is correct. (2)

$6V \rightarrow (27°C + 273) = 300K$

$3V \rightarrow (68°C + 273) = 341K.$

$V \propto \frac{1}{T}$ → Relationship.

$\Rightarrow V = K \cdot \frac{1}{T}$ → Equⁿ.

$\Rightarrow K = VT$

$K = 300 \times 6$ $\quad$ $K = 3 \times 341$

$= 1800\ VK$ $\quad$ $= 1023\ VK.$

Since, the value for constant is not same. Student in incorrect.

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RESISTIVITY:

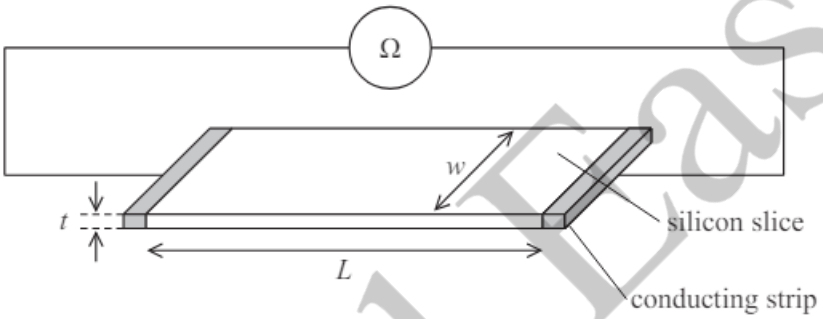
JAN 22

4 A student investigated the resistance of some thin slices of silicon.

Each silicon slice had
- the same length L
- the same thickness t
- a different width w

Conducting strips were fitted to opposite ends of each silicon slice and connected to an ohmmeter, as shown.

The student measured values of w and corresponding values of resistance R.



(a) The table shows the student's measurements.

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w/mm	R/MΩ	1/w (m)
14	33.6	71
18	26.1	56
26	17.2	38
37	13.3	27
53	8.7	19

1/14 × 1000

1/18 × 1000 ←

1/26 × 1000

1/37 × 1000 ←

1/53 × 1000

The relationship between R and w is

$$R = \frac{\rho L}{wt}$$

where ρ is the resistivity of silicon.

(i) Plot a graph of R on the y-axis against $1/w$ on the x-axis. Use the additional column of the table for your processed data.

(6)

Graph.
[y-axis]

30 lines → 10

1 line → $\frac{10}{30} = \frac{1}{3}$.

no. of line $= \frac{8.7}{(1/3)}$

$= 26$

$\frac{13.3}{1/3} = 40$

$\frac{17.2}{1/3} = 52$

$\frac{26.1}{1/3} = 78$

$\frac{33.6}{1/3} = 101.$

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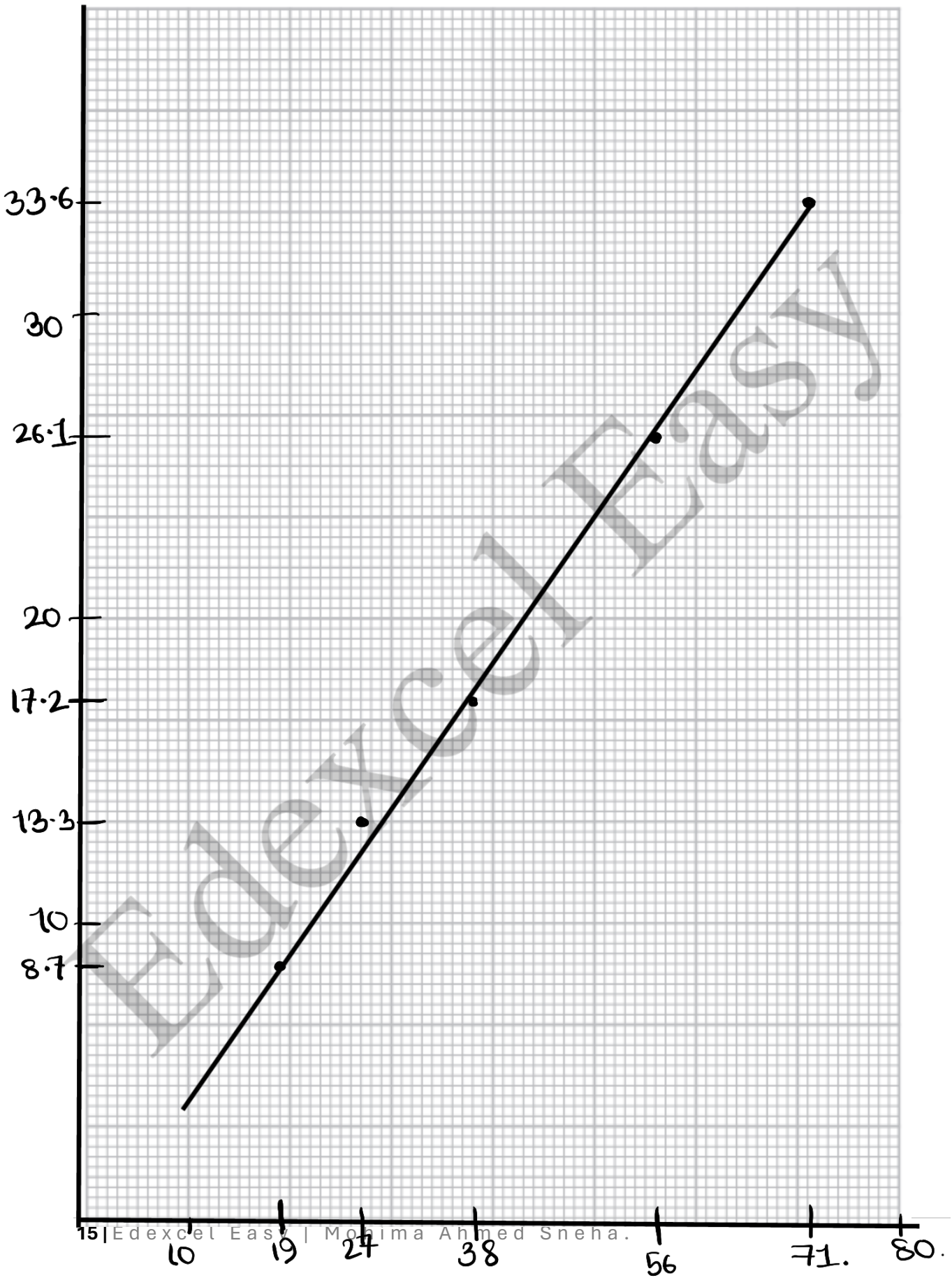

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(ii) Determine t using data from the graph.

$\rho = 4.0 \times 10^3\ \Omega m$
$L = 10.0\,cm$

$$R = \frac{\rho L}{wt}$$

$$\Rightarrow R = \frac{\rho L}{t} \cdot \frac{1}{w} + 0$$

$$y = mx + c.$$

(3)

gradient $= \frac{(26.1 - 13.3) \times 10^6}{56 - 27}$

$= 441379\ \Omega$

$m = 441379$

$\Rightarrow \frac{\rho L}{t} = 441379$

$\Rightarrow t = \frac{4 \times 10^3 \times 0.1}{441379}$

$= 9.06 \times 10^{-4}\ m.$

(b) The student determined a value for t. She decided to measure the thickness of several silicon slices stacked together. She measured this thickness using a micrometer.

RQ (i) Explain why this method gives a value for t with low uncertainty.

(2)

Micrometer has a high resolution of 0.01 mm which gives low uncertainty and there reducing percentage uncertainty.

(ii) The value of t obtained using this method was 0.80 mm with an uncertainty of 2%.

Deduce whether this value is consistent with the value of t obtained from the graph.

(2)

Rough!

$x \rightarrow 98.1.$

$0.8mm \rightarrow 100\%$

$x \rightarrow 102\%$ of 0.8

Upper limit $= \frac{102}{100} \times (0.8 \times 10^{-3})$

$= 8.2 \times 10^{-4}\ m.$

Since $(9.06 \times 10^{-4}) > (8.2 \times 10^{-4})$

Therefore results from graph is inconsistent.

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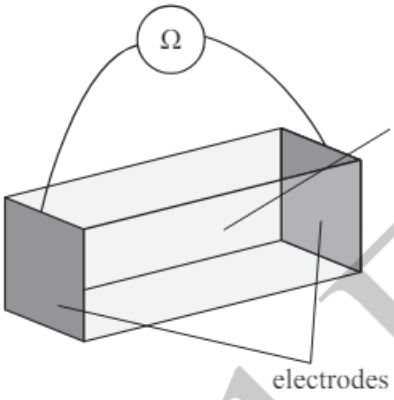
OCT 22

2 A student investigated how dissolving salt in water affects the electrical resistivity of the water.

The student dissolved a known mass m of salt in a known volume of water to make a salt solution.

She filled a container with the salt solution.

The container of length l had an electrode at each end of cross-sectional area A.
She connected an ohmmeter between the two electrodes, as shown.



After measuring the resistance R of the salt solution with the ohmmeter, she calculated the resistivity ρ of the salt solution.

(a) When salt dissolves in water, the salt breaks down into ions. The salt ions are charge carriers.

The student predicted that the resistivity of the salt solution would decrease as m increased.

Justify her prediction.

(3)

m increases the number of charge carriers also increases. According to $I = nAve$ increase in charge carriers increases current. Therefore, from $V = IR$, increased I causes decrease in Resistance. $R = \frac{\rho L}{A}$ resistivity should also decrease when Resistance decreases.

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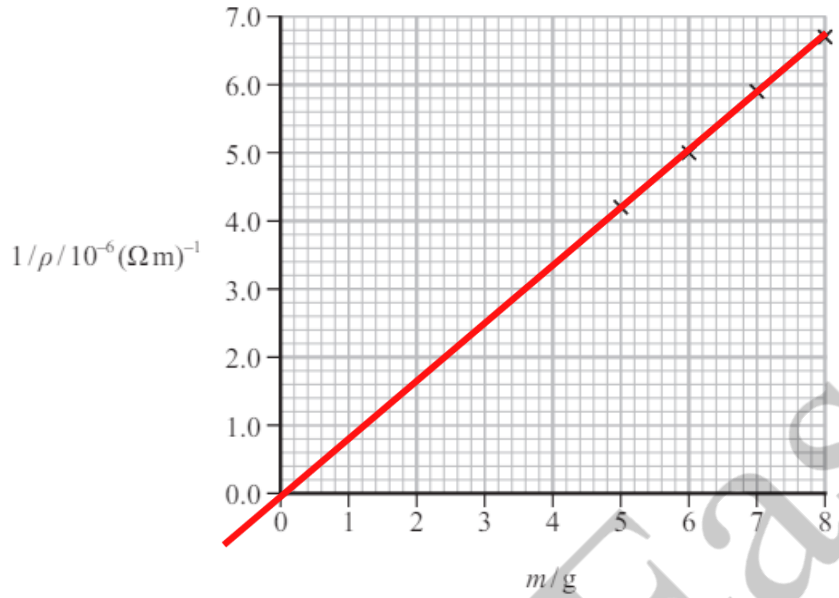
(b) The student repeated the procedure for different values of m and plotted a graph of $1/\rho$ against m.



direct

$\frac{1}{\rho} \propto m.$

(i) The student wrote the following conclusion.

The resistivity of the salt solution is inversely proportional to the mass of salt dissolved in the sample.

Explain how the graph supports the student's conclusion.

(3)

By connecting all the point and extending the graph passes through the origin. This indicates $\frac{1}{\rho} \propto m$ which means student is correct.

(ii) Give two reasons why the graph may not support the student's conclusion. (2)

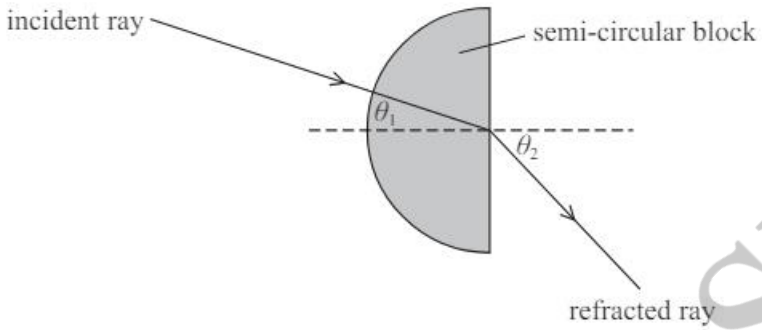
Only four points were plotted and only a small range of masses were used.

Edexcel Easy

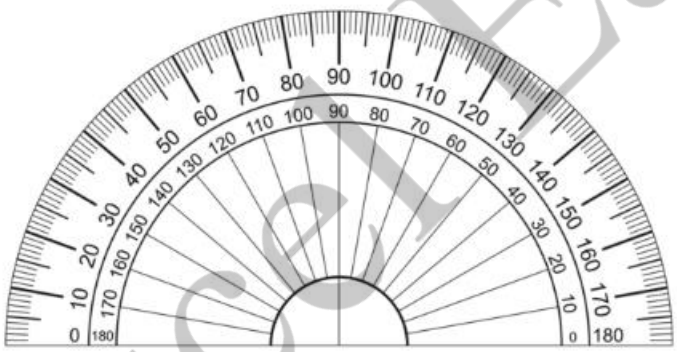
REFRACTIVE INDEX:

JUNE 22

2 A student directed a ray of light from air into a semi-circular block of transparent material as shown.



He varied the angle of incidence θ_1 and measured the corresponding angles of refraction θ_2. He used the protractor shown below.



(Source: PAL)

(a) When the measured value of θ_1 is 35°, the measured value of θ_2 is 62°.

Calculate the percentage uncertainty in each of these values.

(3)

Resolution = 1°

uncertainty = 1°/2

= 0.5°

% uncertainty, $Q_1 = \frac{0.5°}{35°} \times 100$

= 1.43%

% uncertainty, $Q_2 = \frac{0.5°}{62°} \times 100$

= 0.81%

Notes !

Data size $\propto \frac{1}{\%\ U}$

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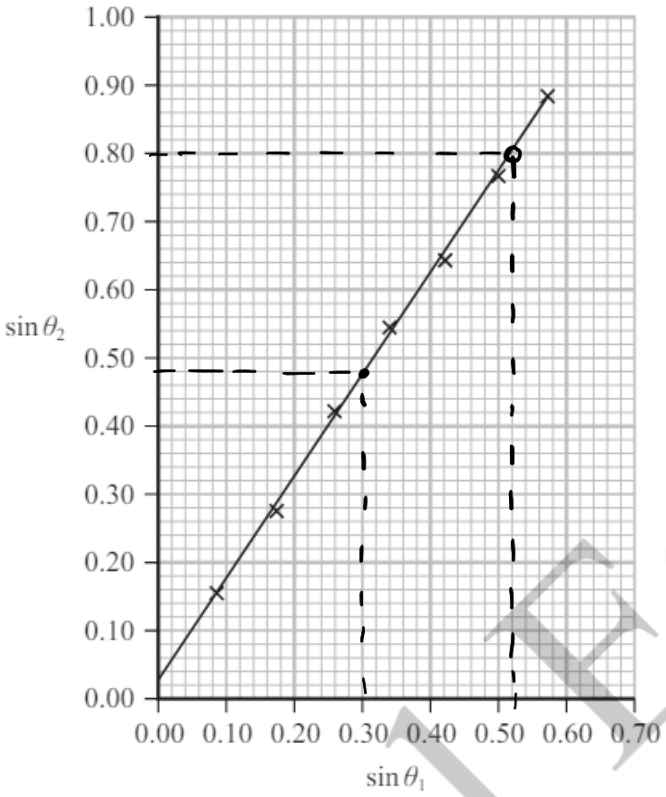
(b) The student plotted a graph of $\sin\theta_2$ against $\sin\theta_1$ as shown.



(i) Explain why the gradient of this graph can be used to determine the refractive index of the transparent material. (3)

gradient = $\frac{\sin\theta_2}{\sin\theta_1}$.

refractive index for material.

$n_a \cdot \sin\theta_1 = n_A \cdot \sin\theta_2 \quad [n_A = 1]$

$\Rightarrow n_a = \frac{\sin\theta_2}{\sin\theta_1}$ ✱//

(ii) Determine the refractive index of the transparent material. (2)

(0.52, 0.8)
(0.3, 0.48)

$\eta = \frac{0.8 - 0.48}{0.52 - 0.3}$

$= 1.46$ //

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(c) The line of best fit on the graph does not pass through the origin. Describe a possible cause for this error, and how the student could reduce the effect of this error. (2)

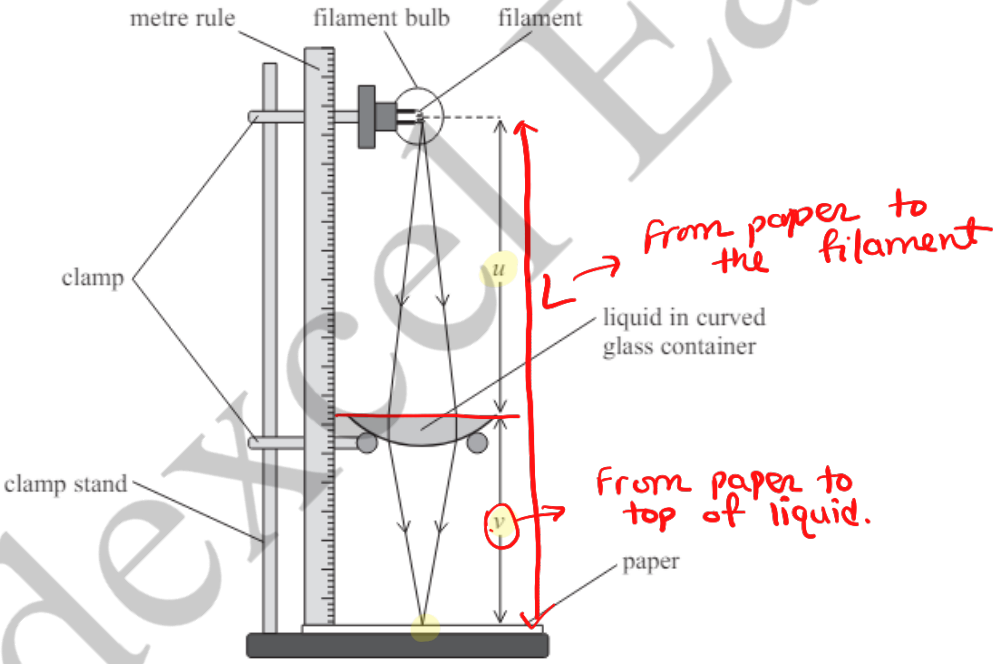
① Normal line might not be correctly drawn perpendicular to the flat surface. To ensure we can use a protractor measure the angle between normal line and flat surface.

OCT 22

3 A student investigated the refractive index of a liquid.

He placed the liquid into a curved glass container so that the liquid acted as a converging lens.

Light from a filament bulb was transmitted through the lens, as shown.



The student adjusted the position of the filament bulb until a clear image of the filament was formed on the paper.

The student calculated the power P of the lens using the distance u between the container and the filament, and the distance v between the container and the paper.

(a) (i) Describe a method to measure u and v. (3)

To measure v, measure the height from paper to top of liquid
To measure u, firs measure the height from paper to the filament and then subtract v from this length.

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(ii) Identify a possible source of uncertainty in the measurement of u, and how it can be dealt with.

(2)

Parallax error when measure the height of u. To overcome this, use set square to keep the ruler perpendicular.

(b) The student repeated the experiment for different values of v and recorded his results in a table.

u/m	v/m	P/D
0.832	0.325	4.28
0.724	0.342	4.31
0.615	0.374	

(i) For a lens, P can be calculated using

$$P = \frac{1}{u} + \frac{1}{v}$$

Calculate the value missing from the table.

(2)

$$P = \frac{1}{0.615} + \frac{1}{0.374}$$

$$= 4.30\,D.$$

(ii) When surrounded by air, the power of a lens this shape can be calculated using the equation

$$P = \frac{n_{lens} - n_{air}}{n_{air}}\left(\frac{1}{r}\right)$$

where r is the radius of the curve that forms the lens

n_{air} is the refractive index of air → 1

n_{lens} is the refractive index of the liquid.

Determine the value of n_{lens} when $r = 0.070$ m.

(3)

$$4.3 = \frac{n_{lens} - 1}{1} \times \frac{1}{0.07}$$

$$\Rightarrow (n_{lens} - 1) = 4.3 \times 0.07$$

$$\Rightarrow n_{lens} = (4.3 \times 0.07) + 1$$

$$\therefore n_{lens} = 1.3.$$

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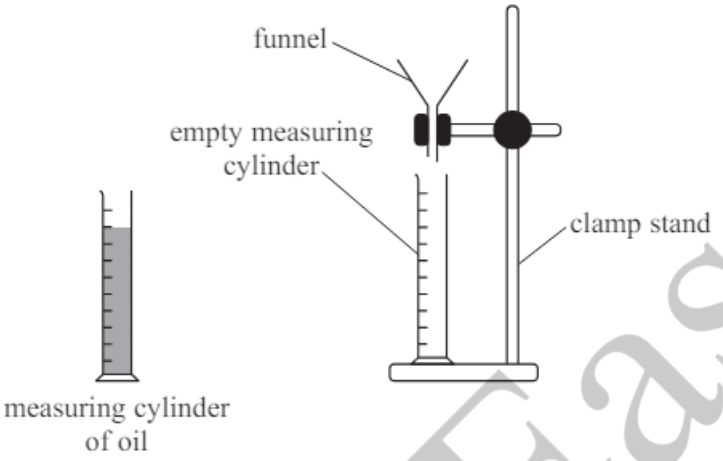
VISCOSITY / DENSITY:

OCT 20

1 A student is investigating the effect of temperature on the viscosity of oil by measuring how fast the oil flows through a funnel. He uses the apparatus shown.



(a) (i) State a piece of apparatus the student could use to vary the temperature of the oil. (1)

water bath.

(ii) State a piece of apparatus the student could use to measure the time taken for the oil to flow through the funnel. (1)

light gates

(b) The two thermometers shown below are available.

liquid-in-glass thermometer

digital thermometer

He chooses to use the digital thermometer.

Justify his choice. (2)

digital thermometer has higher Resolution (0.1) than liquid-in-glass thermometer.
Liquid-in-glass has a chance of parallax error but digital thermometer does not.

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(c) (i) Identify one control variable in this investigation. (1)

volume of oil used.

(ii) Describe how this variable can be controlled. (1)

By using a measuring cylinder.

(d) The student initially measures the time from starting to pour the oil into the funnel to the last drop of oil falling from the funnel. (i) State how the rate of flow of the oil should be calculated. (1)

$$\text{Rate of flow of oil} = \frac{\text{length of funnel}}{\text{Total time}}$$

(ii) Describe how the same apparatus could be used to calculate a more accurate value for the rate of flow of the oil. (2)

Repeat experiment 5-times to calculate average.

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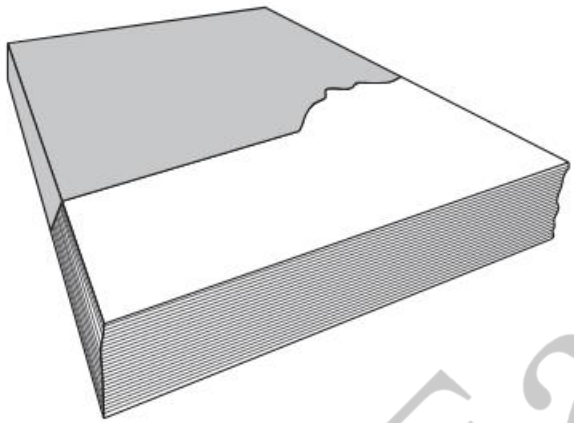
OCT21

1 A student planned an experiment to determine the density of acetate.

She was given a pack of 50 acetate sheets and had access to standard laboratory apparatus.



The approximate dimensions of a single sheet of acetate are given on the pack.

Length	30 cm
Width	21 cm
Thickness	0.15 mm

The total mass of 50 acetate sheets is approximately 670 g.

(a) To determine the density of acetate, the student needed to take measurements.

Complete the table below.

Quantity to be measured	Measuring instrument	Resolution
Mass	Balance	0.1 g
Length and width	Metre rule	1 mm
Thickness	Vernier calipers	0.1 mm

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(b) Describe a method to determine an accurate value for the density of acetate. (4)

Since the sheets are regular shaped, so volume can be calculated using : $V = l \times w \times t$ where all dimesions should be cm.

And mass of one sheet = $\frac{670}{50}$ g.

Then input these data in the equ^{n} : $\rho = \frac{m}{V}$ to calculate density in $g cm^{-3}$.

(c) The student then followed the same method using thicker sheets of acetate. Explain why using thicker sheets of acetate would reduce the uncertainty in her value for density. (2)

Thicker sheets have large thickness which decreases the uncerctainty.

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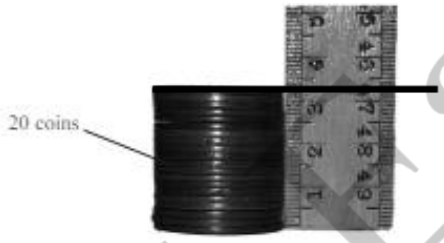
JUNE22

1 A student was given a collection of old coins.

She placed the coins alongside a ruler, as shown, to determine the diameter and thickness of the coins.

→ diameter.

thickness



(a) Determine the average volume of one of the coins. (4)

$r = \frac{30.2 \div 100}{2 \times 10}$

$= 0.0151 m.$

thickness

$= \frac{3.3 \div 100}{20}$

$= 1.65 \times 10^{-3} m.$

$V = At$

$= \pi (0.0151)^2 \times (1.65 \times 10^{-3})$

$= 1.18 \times 10^{-6} m^3$.

Edexcel Easy

(b) The mass of the 20 coins shown is 196g. Determine the average density of the coins. (2)

$$\text{mass} = \frac{196 \div 1000}{20} = 9.8 \times 10^{-3}\ \text{kg}.$$

$$\rho = \frac{m}{V}$$

$$= \frac{9.8 \times 10^{-3}}{1.18 \times 10^{-6}} = 8300\ \text{kg cm}^{-3}.$$

(c) Determine whether the coins could be made from brass.

density of brass = $8550\,\text{kg m}^{-3} \pm 2\%$

(2)

$$\text{upper limit} = \frac{102}{100} \times 8550$$

$$= 8721\ \text{kgm}^{-3}$$

$$\text{lower limit} = \frac{98}{100} \times 8550 = 8379\ \text{kgm}^{-3}.$$

density of coins is smaller than the lower limit of density of brass. Therefore coins are not made up of brass.

(d) The surfaces of the coins are uneven, which introduces a systematic error.

Describe an alternative method the student could have used to determine the average volume of one of the coins, which would avoid this error.

Your description should include details of how any measuring equipment is used.

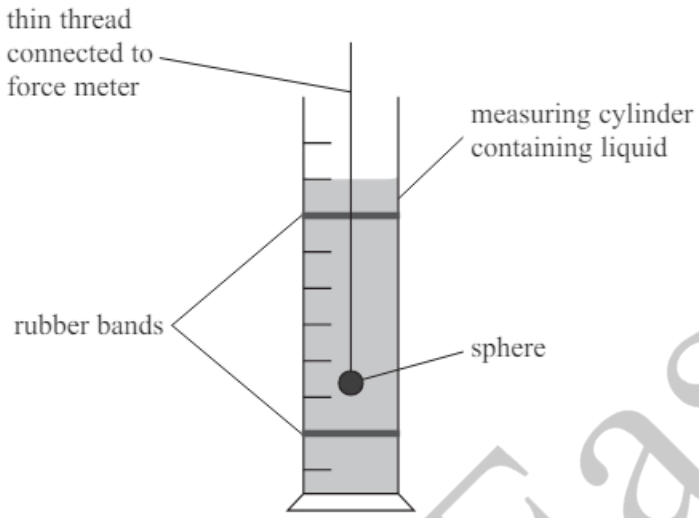
(4)

Could use a vernier caliper that to measure diameter and thickness at different orientations and then calculate mean for diameter and thickness.

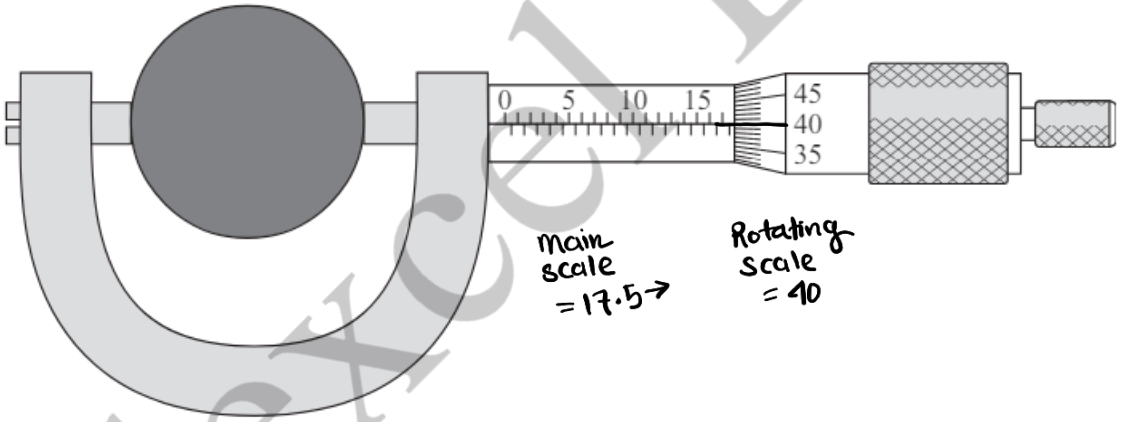
Edexcel Easy

JUNE 21

3 A student determined the viscosity of a liquid. The student measured the force required to pull a small sphere upwards through the liquid at a constant speed.



(a) The student measured the diameter of the sphere using a micrometer.



Calculate the percentage uncertainty in the diameter of the sphere shown on the micrometer. (3)

Reading = 17.5 + (0.01 × 40)
= 17.9 mm.

Uncertainty = $\frac{\text{Resolution}}{2} = \frac{0.01}{2} = 0.005$.

% Uncertainty = $\frac{0.005}{17.9} \times 100$

= 0.03%

Edexcel Easy

(b) State one precaution that should be taken before using a micrometer. (1)

check for zero error.

(c) The student measured the value of force when the sphere was suspended and stationary in the liquid. The force meter used is shown in the photograph.

upward $v = 0.32 m/s$

$F = W + D - U$

Stationary.

$F = W - U$

When the sphere was stationary the reading on the force meter was 0.20 N. $a = 0$

The student then moved the force meter upwards so that the sphere moved at a constant speed of $0.32\,m\,s^{-1}$. The reading on the force meter was 0.29 N. $a = 0$

Edexcel Easy

(i) Explain why it was necessary to measure the force when the sphere was stationary and the force when the sphere was moving at constant speed.

(3)

when stationg, Force meter = W − U
and when it was moving with constant speed, Force meter = W + D − U. Subtracting the two readings can give you drag.

(ii) Calculate the viscosity η of the liquid.

(3)

$F = 6\pi r \eta V$

$\Rightarrow \eta = \frac{F}{6\pi r V}$

$r = \left(\frac{17.2}{2}\right)$

$= \frac{0.09}{6\pi \cdot \left(\frac{17.2}{2}\right) \times 0.32}$

$= 1.7 \times 10^{-3}$ Pas.

(d) The resolution of the force meter was 0.01 N.
The distance moved between the rubber bands was 25.0 cm.
The time measured was 0.78 s.
The percentage uncertainty in the measurement of the diameter was negligible.

RQ

Assess which of these measurements was the most significant source of uncertainty in the value of viscosity.

(4)

$F = \frac{0.01 \div 2}{0.09} \times 100 = 5.6\%$

1 mm = 0.1 cm

$d = \frac{0.1 \div 2}{25} \times 100 = 0.2\%$

$t = \frac{0.01 \div 2}{0.78} \times 100 = 0.64\%$

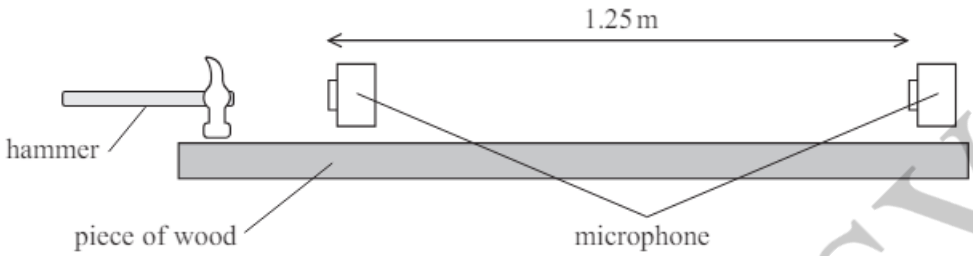
Force has the most significant source of uncertainty in the calculation.

Edexcel Easy

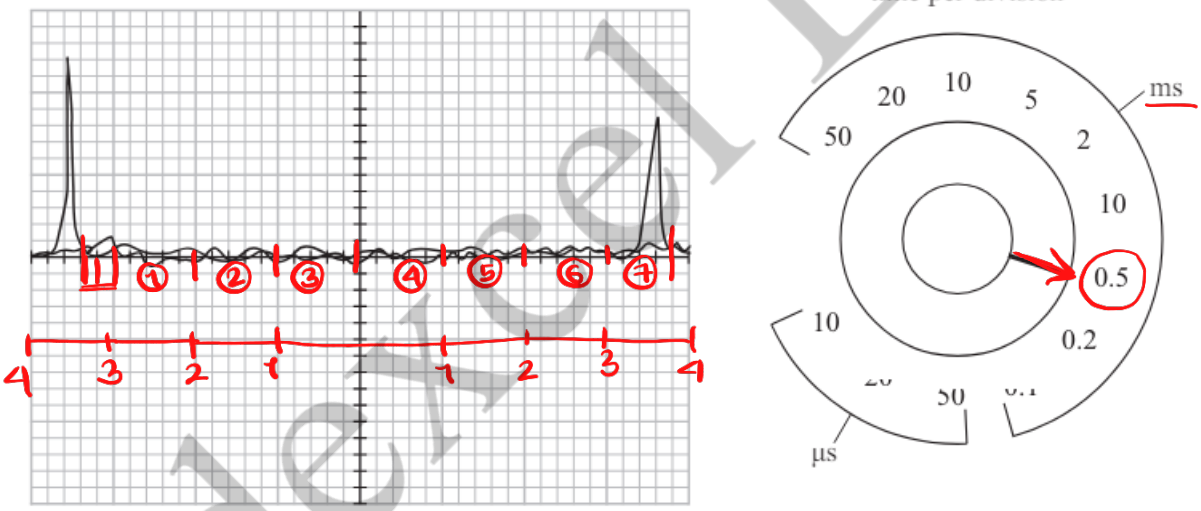
SOUND:

JAN 22

5 A student carried out an experiment to compare the speed of sound in air and the speed of sound in wood. The student used a long piece of wood, a hammer and two microphones, as shown.



The microphones were connected to a 2-beam oscilloscope. The student hit the wood with a metal hammer producing a sharp sound that travelled through the air. The oscilloscope traces produced by the microphones and the time per division dial are shown.



Edexcel Easy

(a) (i) Determine the speed of sound in air.

distance between microphones = 1.25 m

(4)

1 box $= 0.5 \times 10^{-3}$

7.2 box $= 7.2 \times 0.5 \times 10^{-3}$

$$V = \frac{1.25}{7.2 \times 0.5 \times 10^{-3}}$$

$= 347$ m/s.

(ii) The student then attached the microphones to the piece of wood so they detected the sound passing along the wood. The distance between the microphones was 1.25 m.

The student adjusted the dial on the oscilloscope to 20 μs per division to display the traces from the microphones. A teacher commented that this was not the correct setting.

Justify the teacher's comment.

The piece of wood is made of oak. The speed of sound in oak is approximately 4000 m s^{-1}.

(3)

time taken $= \frac{1.25}{4000} = 3.1 \times 10^{-4}$ s

$= 310$ μs.

max time on display $= 20\ \mu s \times 8$

$= 160$ μs.

display is too short to represent both peaks on screen.

Edexcel Easy

(b) The student tried the same experiment using a rubber hammer. The rubber hammer compressed as it hit the wood making a sound that lasted for a longer time.

Explain the effect that using the rubber hammer had on the accuracy of the time determined.

Peaks would be much wider so it would be difficult to position the peaks therefore making data less accurate.

(2)

(c) The student was given the following equation and data to find a value for the speed of sound in oak.

$$v = \sqrt{\frac{E}{\rho}}$$

Young modulus E of oak = 11.2 GPa ± 0.5 GPa
Density ρ of oak = 650 kg m^{-3} with an uncertainty of 3%

Assess which of these values was the more significant source of uncertainty in the value of the speed of sound.

(2)

$$E = \frac{0.5}{11.2} \times 100 = 4.46\%$$

As $\%U_E > \%U_\rho$, therefore Young Modulus have greater source of uncertainty.

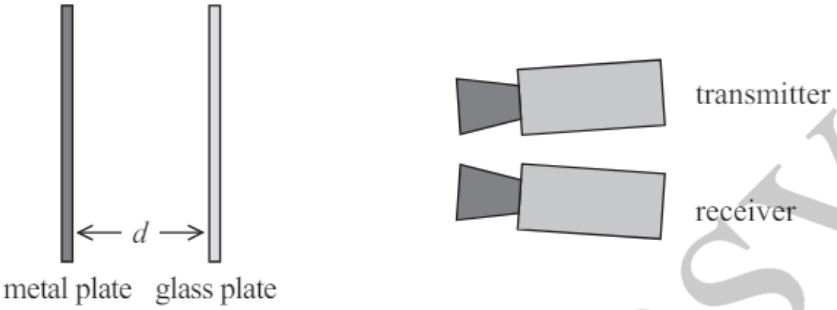
Edexcel Easy

OCT 21

2 A student investigated the reflection of microwaves from a metal plate and a glass plate.

The metal plate reflects microwaves and the glass plate partially reflects microwaves.

A plan view of the apparatus is shown.



The metal plate, the transmitter and the receiver were kept in fixed positions.

The value of d was varied by moving the glass plate.

(a) As d varied, the intensity of the microwaves detected by the receiver varied.

Explain why.

(3)

When d changes path difference microwaves reflected from metal plate and glass plate changes. These reflected waves interefere at the receiver. Therefore when path difference changes it either cause constructive or destructive interferrence.

Edexcel Easy

(b) The student recorded values of d when the receiver showed a maximum value of intensity.

He recorded d for a sequence of five maxima.

Maxima	1	2	3	4	5
d / cm	9.9	11.1	12.7	13.9	15.4

1.2 1.6 1.2 1.5

(i) Determine the wavelength of the microwaves being transmitted. (3)

mean distance between maxima. $= \frac{1.2+1.2+1.6+1.5}{4}$

$= 1.38$ cm. [not a whole no.]

minimum destructive $= (0+\frac{1}{2})n$

Destructive interence $= (n+\frac{1}{2})\lambda$

$= (0+\frac{1}{2})\lambda = 1.38$ cm

$\Rightarrow \lambda = 2 \times 1.38$

$\therefore \lambda = 2.8$ cm //

minimum constructive $= (1\lambda)$

(ii) Calculate the frequency of the microwaves being transmitted. (2)

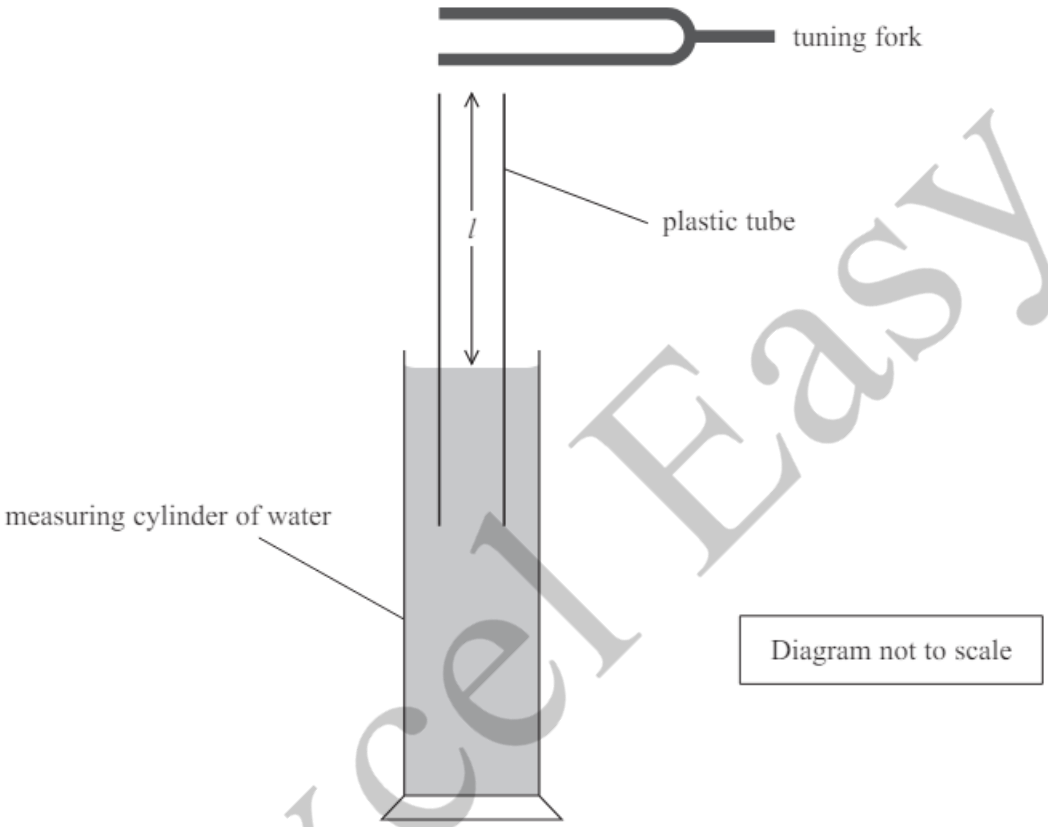
$f = \frac{v}{\lambda}$

$= \frac{3 \times 10^{-8}}{0.028} = 1.1 \times 10^{10}$ Hz.

Edexcel Easy

2 A student determined the speed of sound in air using a standing wave.

The student used a tuning fork to create a sound wave in the column of air inside a plastic tube. He placed the plastic tube into a measuring cylinder of water so he could adjust the length *l* of the column of air.



The student adjusted *l* until the loudest sound was heard, indicating that a standing wave had formed. He marked the water level on the plastic tube and measured *l*.

He repeated this process several times and recorded the results.

l / cm	18.4	18.0	19.2	19.4	19.2

(a) Suggest two reasons for the variation in the lengths the student measured.

(2)

Difficult to identify when sound was loudest and tube moves when the student was trying the mark the water level.

Edexcel Easy

(b) (i) Calculate the mean value of l. (2)

$$l = \frac{18.4 + 18.0 + 19.2 + 19.4 + 19.2}{5}$$

$$= 18.8\,cm$$

(ii) Calculate the percentage uncertainty in l. (2)

Range $= 19.4 - 18 = 1.4\,cm.$

Uncertainty $=$ Range$/2 = 1.4/2 = 0.7\,cm.$

$$\% \text{ Uncertainty} = \frac{0.7}{18.8} \times 100 = 3.7\ \%$$

(c) The frequency of the tuning fork was 440Hz. The standing wave produced had a wavelength 4l.

Calculate the speed of sound in air. (2)

$$v = 440 \times 4\,(0.188)$$

$$= 331\,m/s.$$

(d) The percentage uncertainty in the student's value for the speed of sound is equal to the percentage uncertainty in *l*.

The accepted value for the speed of sound in air is 343 $m\,s^{-1}$.

Comment on whether the student's value is consistent with the accepted value for the speed of sound in air.

(2)

$$\%\ U(\text{speed}) = 3.7\ \%$$

$$\text{upper limit} = \frac{103.7}{100} \times 331$$

$$= 343.247\,m/s.$$

As upper limit for calculated data is almost equal to given value. Therefore student's value is consistent with accepted value.

Edexcel Easy

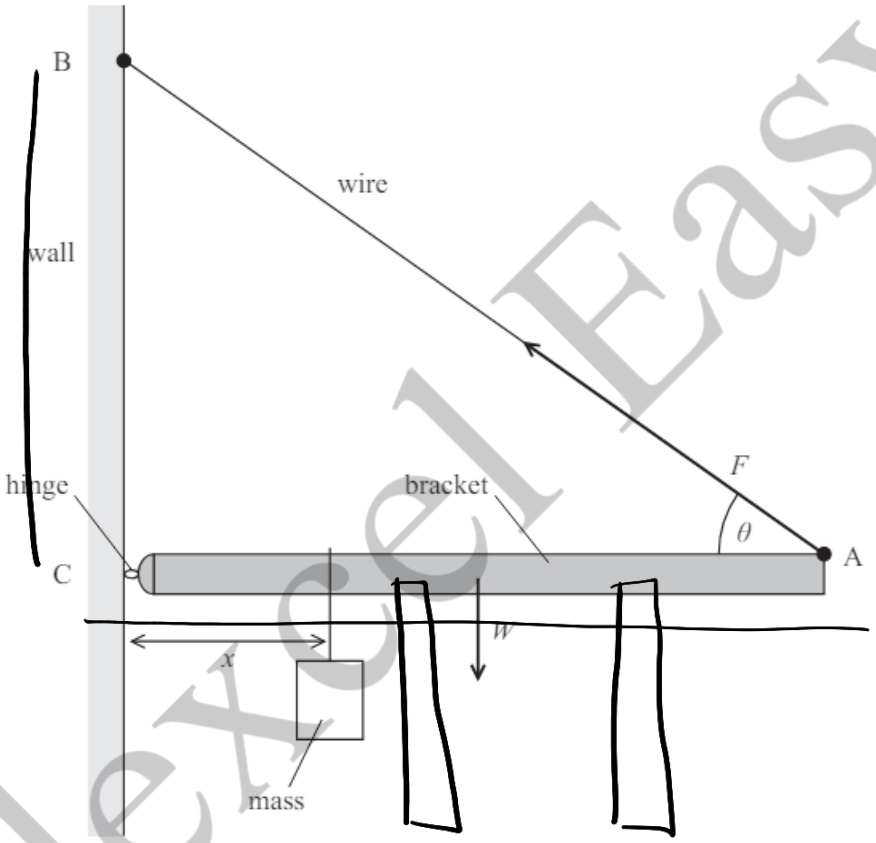
TENSILE FORCES:

JAN 22

3 A student investigated the forces acting on a bracket.

The bracket of weight W was attached to a vertical wall with a hinge at point C. The bracket was held horizontally by a wire attached to the bracket at point A and to the wall at point B. The wire was at an angle θ to the bracket and exerted a force F on the bracket.

The student hung a mass from the bracket at a distance x from the hinge, as shown.



(a) Describe how the student could determine θ using a metre rule. (2)

they can measure the lengthe BC and AC then use the equⁿ : $\theta = \sin^{-1}\left(\frac{BC}{AC}\right)$.

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(b) Describe how the student could check that the bracket was horizontal. (1)

Measure the distance from the bracket to the floor at two position.

(c) The student adjusted the position of the mass and measured x. For each value of x the student made corresponding measurements of F using a force meter. The results are shown in the table.

x/cm	Mean F/N
5	2
10	2.6
15	3.3
20	4.4
25	5.3
30	6.2
35	7
40	8.1
45	8.8

5 | 2.1, 2.2, 2.01

Criticise the recording of these results. (3)

Inconsistent sig. fig. for mean F and x was only measured to the nearest cm. Original data are not represented.

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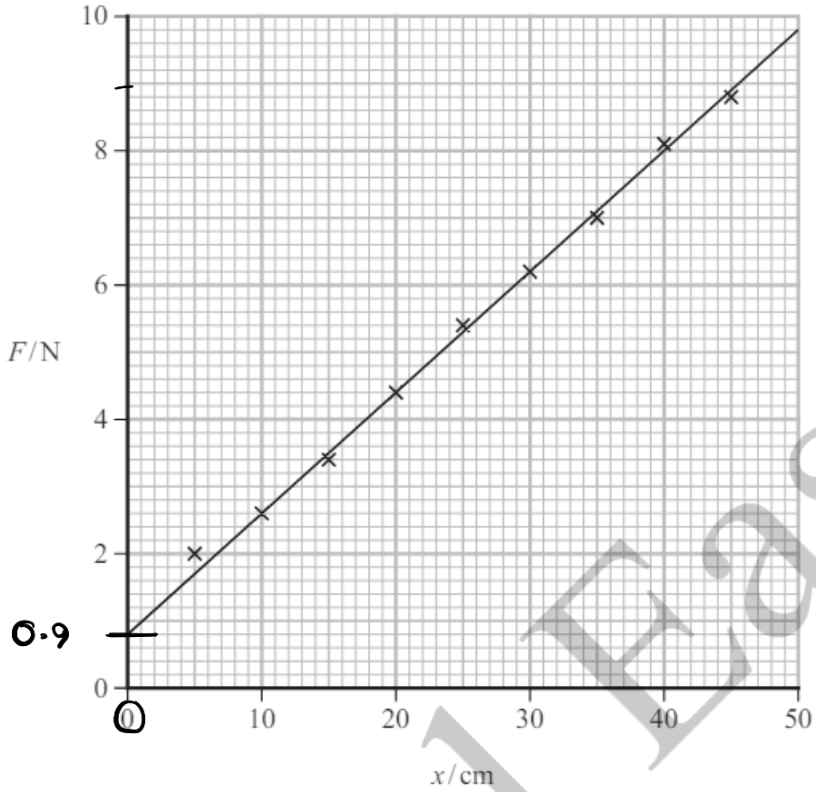
(d) The student plotted a graph of F against x, as shown.



(i) The relationship between F and x is

$$F = \frac{mgx}{l\sin\theta} + \frac{W}{2\sin\theta}$$

where

l is the length of the bracket
m is the mass hung from the bracket.

Determine a value for W using the graph.

$\theta = 42°$

$$\Rightarrow 0.9 = \frac{mg(0)}{l\sin 42°} + \frac{W}{2\sin 42°}$$

$$\Rightarrow W = 0.9 \times 2 \times \sin 42°$$

$$= 1.1\text{N}.$$

(3)

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(ii) The value of g obtained from the graph is $9.64\,m\,s^{-2}$.

The student concluded that the value of g obtained is accurate.

Evaluate the student's conclusion.

% difference = $\frac{9.81-9.64}{9.64} \times 100$ (2)

$= 1.7\%$

% difference is small. So method is accurate.

OCT 20

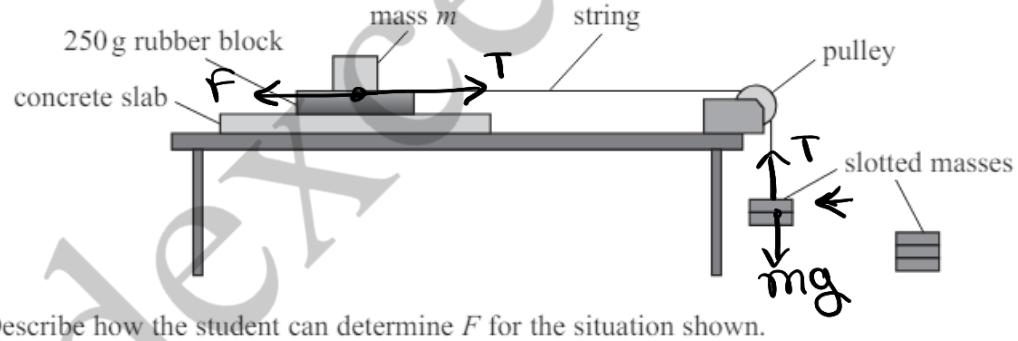
4 When an object is in contact with a horizontal surface, there is a maximum frictional force F between the object and the surface before sliding occurs.

F is given by the equation

$$F = \mu N$$

where μ is a constant and N is the normal contact force between the object and the surface.

A student investigated this relationship for a rubber block on a concrete surface. She set up the apparatus as shown in the diagram.



(a) Describe how the student can determine F for the situation shown. (2)

Slotted mass: $\uparrow F = 0$

$\Rightarrow mg - T = 0$

$\therefore T = mg$.

Slab: $\rightarrow F = 0$

$\Rightarrow T - F = 0$

$\Rightarrow F = T = mg$.

Increase the mass of the slotted masses until the rubber block starts to slide. Then friction will be equal to the weights on slotted mass.

Edexcel Easy

(b) The student varied the mass m placed on top of the rubber block and determined corresponding values of F.

Her results are shown in the table.

m/g	N/N	F/N
0	2.45	1.4
200	4.41	2.5
400	6.38	4.0
600	8.34	4.6
800	10.3	5.8

$= m + 250g.$

(i) Explain how the values of N are calculated. (2)

$N = W$

$\Rightarrow N = (m + 250)g.$

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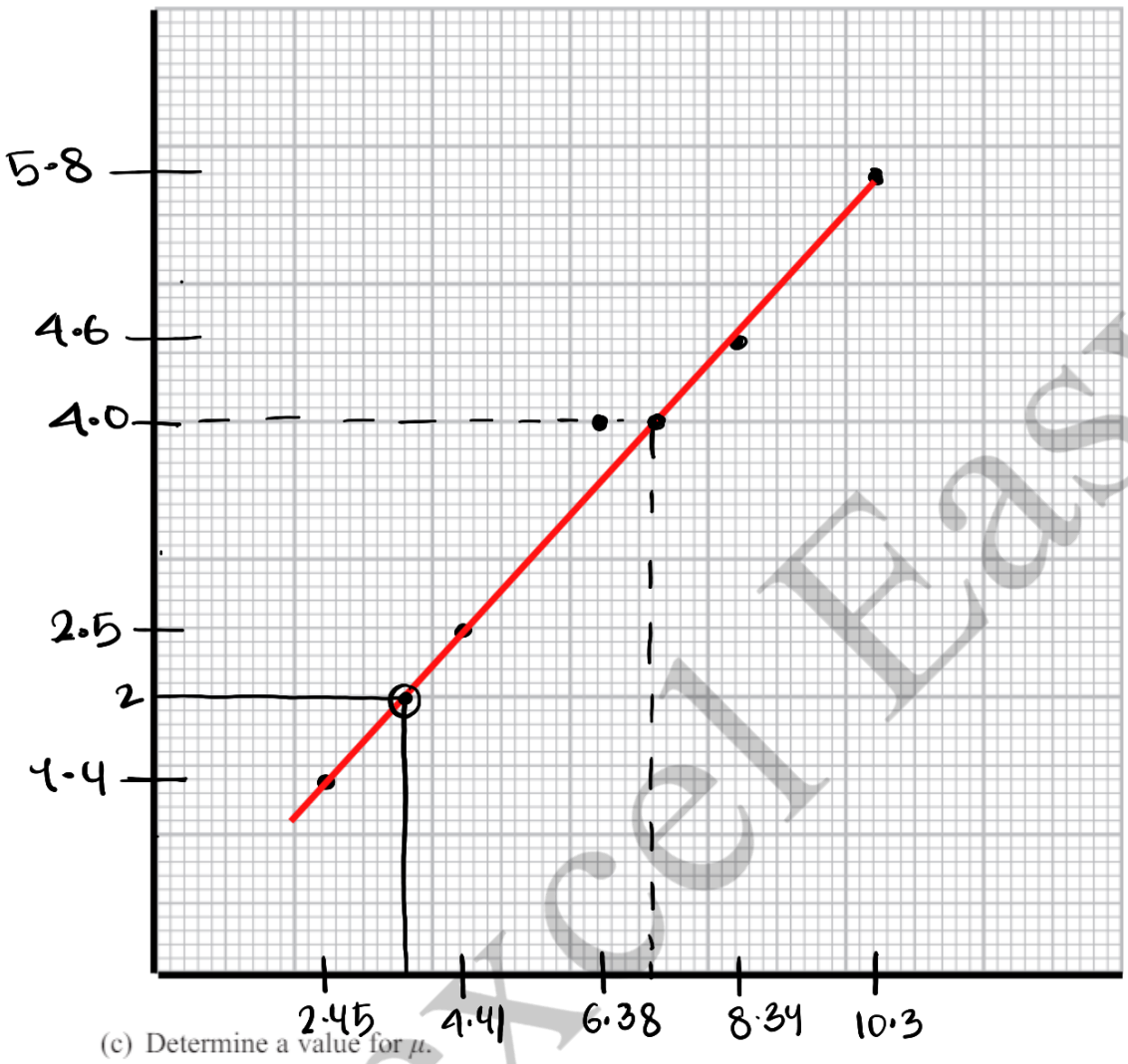
(ii) Plot a graph of F on the y-axis against N on the x-axis using the grid below.

(5)



F
1·4 → 5·8
2·45 → 10·3
N

(c) Determine a value for μ.

(3)

$$F = \mu N$$

$$\Rightarrow \mu = \frac{F}{N}$$

$$= \frac{2 - 4}{3 \cdot 6 - 7 \cdot 2}$$

$$= 0 \cdot 56.$$ //

Edexcel Easy

(d) A tyre manufacturer carries out similar tests on samples of the rubber used for tyres.

Suggest why these tests are necessary. with

To tests provide us, the maximum braking force which can be used to determine safe distance for the car to come to rest. (2)

OCT 21

3 A student was asked to investigate the ultimate tensile stress of a sample of thin nylon fishing line. (a) Describe a method to determine the maximum force the nylon fishing line can withstand before breaking. (4)

Edexcel Easy